

2/M-24 (v) (Syllabus-2005)

2009

PHYSICS

(Honours)

FIFTH PAPER (Phys-211)

(Thermal and Statistical Physics)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer any five questions

-
1. (a) Define normal distribution. Which physical conditions lead to this distribution? Discuss its properties.

2+2+3=7

- (b) Explain the basic principles of the kinetic theory of gases. Give kinetic interpretation of temperature.

3+2=5

2. (a) Show that the mean free path of a gas molecule is inversely proportional to the pressure.

3

- (b) Derive an expression for thermal conductivity of a gas on the basis of kinetic theory of gases. Show that coefficient of thermal conductivity of hydrogen should be largest among all diatomic molecules. 5+4=9

3. (a) State first law of thermodynamics. Give its physical significance. What are the limitations of the first law? 2+2+2=6

- (b) State and prove Carnot's theorem. 2+4=6

4. (a) Prove the following thermodynamic relations

$$(i) \left(\frac{\partial S}{\partial P} \right)_T = - \left(\frac{\partial V}{\partial T} \right)_P$$

$$(ii) T dS = C_P dT - T \left(\frac{\partial V}{\partial T} \right)_P dP$$

where the symbols have their usual meanings. 4×2=8

- (b) Define four thermodynamic potentials U , F , H and G . 4

5. (a) Explain Joule-Thomson effect using the Maxwell's thermodynamic relations. 5

- (b) What do you mean by liquefaction of gases? Mention various methods used for liquefaction of gases. Discuss the difficulties encountered in liquefying hydrogen and helium. 1½+1½+4=7

6. (a) Explain the terms macrostate and microstate with the help of an example. 6

(b) Calculate the number of phase cells, $\phi(E)$, in energy range 0 to E for a 1-D harmonic oscillator. 6

7. (a) Deduce the Maxwell-Boltzmann distribution law

$$n_i = g_i \exp(-\alpha - \beta \epsilon_i)$$

where the symbols have their usual meanings. 8

(b) Calculate the r.m.s. velocity of a molecule of hydrogen at 27 °C. The Boltzmann's constant is 1.38×10^{-23} J/deg and

Avogadro's number is 6.02×10^{23} /mole. 4

8. (a) What is meant by indistinguishability of particles? What role it plays in quantum statistics? What are its consequences?

2+2+4=8

(b) State Stefan-Boltzmann law of heat radiation. Two large closely spaced concentric spheres (both are blackbody radiators) are maintained at temperatures 400 K and 600 K, respectively. The space in between the two spheres is evacuated. Calculate net rate of energy transfer between the two spheres.

2+2=4

$[\sigma = 5.672 \times 10^{-8}$ MKS units]
